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DIGITAL COMPUTER NEWSLETTER

The purpose of this newsletter is to provide a medium for the interchange among interested persons of information concerning recent developments in various digital computer projects. Distribution is limited to government agencies, contractors, and contributors.

OFFICE OF NAVAL RESEARCH · MATHEMATICAL SCIENCES DIVISION

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The Under Secretary of the Navy
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Editorial Policy Notices

EDITORIAL

The Digital Computer Newsletter, although a Department of the Navy publication, is not restricted to the publication of Navy-originated material. The Office of Naval Research welcomes contributions to the Newsletter from any source. The Newsletter is subjected to certain limitations in size which prevent publishing all the material received. However, items which are not printed are kept on file and are made available to interested personnel within the Government.

DCN is published quarterly (January, April, July, and October). Material for specific issues must be received by the editor at least three months in advance.

It is to be noted that the publication of information pertaining to commercial products does not, in any way, imply Navy approval of those products, nor does it mean that Navy vouches for the accuracy of the statements made by the various contributors. The information contained herein is to be considered only as being representative of the state-of-the-art and not as the sole product or technique available.

CONTRIBUTIONS

The Office of Naval Research welcomes contributions to the Newsletter from any source. Your contributions will provide assistance in improving the contents of the publication, thereby making it an even better medium for the exchange of information between government laboratories, academic institutions, and industry. It is hoped that the readers will participate to an even greater extent than in the past in transmitting technical material and suggestions to the editor for future issues. Material for specific issues must be received by the editor at least three months in advance. It is often impossible for the editor, because of limited time and personnel, to acknowledge individually all material received.

CIRCULATION

The Newsletter is distributed, without charge, to interested military and government agencies, to contractors for the Federal Government, and to contributors of material for publication.

For many years, in addition to the ONR initial distribution, the Newsletter was reprinted by the Association for Computing Machinery as a supplement to their Journal and, more recently, as a supplement to their Communications. The Association decided that their Communications could better serve its members by concentrating on ACM editorial material. Accordingly, effective with the combined January-April 1961 issue, the Newsletter became available only by direct distribution from the Office of Naval Research.

Requests to receive the Newsletter regularly should be submitted to the editor. Contractors of the Federal Government should reference applicable contracts in their requests.

All communications pertaining to the Newsletter should be addressed to:

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Computing Centers

IBM 360 Duplex Computer System

Allegheny Airlines
Washington, D.C. 20021

Allegheny Airlines' Senior Vice President, Walter J. Short, announced in September 1966 that Allegheny is installing an IBM 360 Duplex Computer System costing nearly three-quarters of a million dollars. The system, which was specifically tailored to Allegheny's operation, uses two IBM System/360 Model 30's for data processing and data communications. Allegheny is the only Regional Airline that has completed plans for two completely interchangeable computer systems to service communications and data processing requirements.

Mr. Short said, "One of the IBM 360 Computers will be 'communications dedicated' and will become the brain of Allegheny's communications center which serves a teletype network linking together over 50 cities." The company now has a manual "torn tape" message switching system.

"The new system will receive current operational data 24 hours a day, automatically relay messages, store and convert data for processing and feed data to an identical IBM 360 Computer which will be used for business processing," Mr. Short said.

The ability of either computer to perform the other's function is a unique feature of the duplex system.

The business processing computer will handle general accounting, payrolls, personnel, transactions with other airlines, computer control of inventories, and time control of aircraft parts. Plans also include computerizing aircraft maintenance functions such as labor and shop records.

Mr. Short said that Allegheny is also studying future applications possible with the new duplex computer system in the areas of turbine engine analysis, airport runway analysis, reservations and flight information, and an expanded management information system.

The first computer was installed in November 1966 and is primarily for business processing. The data communications system is expected in April 1967.

Stock Exchange Automation

American Stock Exchange
New York, N.Y. 10006

The American Stock Exchange has contracted with the General Electric Company to obtain a computer complex that will drive the Exchange's sales and quotation tickers, monitor trade data for accuracy, increase the speed and scope of stock watch and market surveillance programs, and provide a compared clearance.

In this central step of the Exchange's long-range automation program, two GE-415 computers and related equipment were received in December. Following a break-in and testing period, the system will be placed on-line to launch a compared clearance program as soon after the first of the year as possible.

The Exchange will lease the equipment from General Electric at an annual cost of $420,000, or $35,000 a month. The net added cost to the Exchange, for a wide range of new services, will be about $14,000 a month after release of equipment to be replaced by the computer.

The two third-generation computers will be located in the Exchange's Clearing Corporation

at 4 Albany Street, where they will replace three computers and the related EAM equipment currently performing the clearing operation.

The computers will be phased into operation over a period of time. The initial task will be to inaugurate a compared clearance with full back-up on premises. A compared clearance involves matching reports of both the buying and selling brokerage houses. The Exchange now processes reports only from the selling broker.

By mid-1967, the two computers, aligned in parallel, will drive the stock and quotation tickers and will provide the Exchange with a preliminary automated market surveillance and stock watch capability.

Exchange President Edwin D. Etherington said, "The Exchange's goal is to formulate a balanced, up-to-date computer capability to help serve member organizations and the investing public.

"The computer complex has been selected with great care after months of systems and design study. The total automation and communications program is designed not merely to further the speed, accuracy, and efficiency of current services, but also to permit the Exchange to take advantage of future innovations and to coordinate its efforts with automation programs of brokerage houses and other securities industry organizations," Mr. Etherington added.

"Advanced communications techniques are now being designed for the Exchange to take full advantage of this increased data processing capacity. Existing ticker and quotation services are to be stepped up in efficiency. Clearing, market surveillance, and stock watch systems are being developed and expanded to take advantage of computer capability," he said.

ELECTRONIC KEYBOARDS NOW IN OPERATION

As part of the integrated automation program, the computer complex will monitor the output of a system, recently implemented, for direct floor-to-ticker transmission of market data through electronic keyboards at every trading post.

Currently, 22 keyboards at 11 trading posts are flashing stock prices on about one half of the total list of 1,000 securities direct from the floor to the nationwide ticker network—cutting the present time interval from an average of 3 minutes to a matter of seconds. By the end of August, it is expected that all 46 keyboards, supplied by The Bunker-Ramo Corporation, will be phased into operation at the 23 trading posts on the Exchange floor.

The computer complex, in monitoring the tickers for accuracy, will assemble market data from the electronic keyboards in a split-second operation and examine every sale before transmission on the ticker in a continuous validity check. The system will intercept possible errors and permit corrections to be made before the errors appear on tickers.

Following is an example of how the validity check works:

An issue is quoted 25-1/2 bid, offered at 25-3/4, and the data clerk at the keyboard who means to transmit a 25-1/2 sales figure inadvertently "keys" it into the system as 52-1/2. The computer will be programmed to stop the error and alert Exchange personnel to make corrections before the incorrect information appears on the ticker.

COMPUTER HANDLES COMPARED CLEARANCE

For compared clearance, the computer system will match reports of both the buying and selling brokerage houses involved in a transaction. The system is designed to handle initially 70,000 trades daily—a volume approximately equal to an 8-million-share-day on the trading floor. Thus far in 1966, volume has averaged 3.4 million shares a day, although in April it exceeded 6 million shares on three occasions.

In matching reports of both the buyer and seller, the computer will detect mismatches and reduce the amount of paper work in member organization back offices. Since the Clearing Corporation now processes reports only from the selling broker, and develops the "buy" side from this one-sided input, a two-sided input is expected to decrease substantially the number of trades which are difficult to compare.

STOCK WATCH, SURVEILLANCE KEY TO SELF-REGULATION

The new computer capability will broaden the scope and increase the efficiency of the

stock watch and market surveillance programs. These activities are key aspects of the Exchange's broad program of self-regulation keyed to the public's need for fair and orderly markets. Stock watch is a system for detecting and inquiring into unusual price movements or activity. Surveillance programs help assess the depth, continuity, and orderliness of markets.

GE-415 CONFIGURATION

The complete GE-415 computer system being delivered to the Exchange includes two central processors, each with a 32,000-word memory and console typewriters for directing the computers' operation and checking their memory content.

Also included are two high-speed card readers, three card punchers, three 1,200-line-per-minute printers, and seven magnetic tape handlers capable of "reading" and "writing" up to 60,000 characters per second.

Storage and recall of information in computer memory will be supplemented by three disc storage units. Each disc storage unit will be equipped with a full complement of 16 magnetic discs with a capacity of more than 23 million characters per unit. They are capable of "reading" and "writing" as many as 83,000 characters per second.

Expanded Computer Facilities

Argonne National Laboratory
Argonne, Illinois 60439

Argonne National Laboratory is extensively enlarging its electronic computer capacity to meet the needs of scientists and engineers conducting research on peaceful uses of atomic energy.

Dr. Albert V. Crewe, Director of Argonne, announced that the Laboratory is acquiring two large IBM System/360 digital computers. One of the computers, a Model 50, already is in operation in Argonne's Applied Mathematics Building. The other, a larger Model 75, will be installed in June 1967. When both System/360s are in use, Argonne will have one of the nation's largest scientific computing systems.

Dr. J. Wallace Givens, Director of the Applied Mathematics Division, said the new facilities will greatly increase the Laboratory's capacity for handling and analyzing experimental data. "In addition," he said, "the computers should improve our capabilities for doing research on information processing systems and on mathematical theories of science and engineering."

The computers, which will cost $4.5 million are being installed at the Argonne Computing Center in the Applied Mathematics Building. They will share the Center's big machine room with another large computer, a Control Data Corporation Model 3600, which was acquired in 1963.

At the present time the IBM Model 50 is being used to analyze experimental data as a supplement to the 3600. When the Model 75 arrives, the Model 50 will serve as its "front end." It will perform input-output and control functions for the bigger Model 75. The Model 75, using its high speed and large capacity for handling information will do the actual computation.

Operation of the new computers is being directed by Dr. Wayne R. Cowell, Head of the Computing Center, and by Clifford G. LeVee, Computer Operations Manager.

Mr. LeVee said that, in addition to conventional computing ability, the new complex will have several small nearby consoles for direct use by individual scientists. Each scientist will appear to have exclusive use of the system while actually sharing the computers' tremendous speed and memory. The two System/360s may form the nucleus of a data network and analysis system, with remote stations in many of Argonne's laboratories.

The new computers will have three types of memories for storing data.

- One consists of banks of hundreds of thousands of tiny magnetic cores. This type of memory, though limited in capacity because of its high cost, is capable of finding wanted data in less than a millionth of a second. In most applications this high-speed memory retains information that is needed frequently for solving a particular problem, such as a program of instructions.

- Another type of memory operates at an intermediate speed. It stores large amounts of data on the surfaces of magnetic discs. This type is slower because its operation is partly mechanical; however, an entire disc can be searched for information in a few thousandths of a second. One feature of the IBM System/360 is that these magnetic discs can be removed from the computer and stored or carried to another IBM computer to be "played" like phonograph records.
- A third type of memory is supplemental and has an unlimited capacity for storing information. Data are stored on magnetic tape, punched paper tape, or punched cards. When needed, this information is "read" into one of the faster memories much as the playback of an ordinary tape recording. At Argonne, tapes recorded for the 3600 and System/360 computers will be used interchangeably.

To permit close man-machine interaction with the IBM computers, Argonne has ordered ten cathode ray tube devices which show computed information on screens that resemble the screens of television sets. Two of these devices will be equipped with light pens so that scientists can participate in the computation process by drawing or writing data on the face of the screen.

Argonne's Applied Mathematics Division was one of the first organizations to pursue the development of large-scale scientific computers. Yet, only 10 years ago, the Laboratory's single high-speed digital computer AVIDAC was capable of "remembering" only 512 words, numbers, or terms. Today's computers have high-speed memories of capacity several hundred times that of AVIDAC and operate at speeds that are hundreds of times faster.

The Laboratory uses computers in a wide variety of applications—from running an experimental design check on a hypothetical nuclear reactor, to determining the chances for survival of an organism exposed to radiation, to measuring the billionths-of-a-second lifetimes of man-made subnuclear particles.

Argonne has been a leader in developing scientific uses of computers—such as systems which provide automatic control of experiments and other systems capable of nuclear particle tracks, of bone cells, or of fingerprints.

The IBM System/360 is a solid-state general-purpose computer system designed for commercial, scientific, communications or control applications. The compact system uses micro-miniature circuits instead of electronic tubes or transistors. The resulting compactness will mean that the entire Model 50 and 75 installation will use less space than was required by AVIDAC. The problem and instructions prepared for Argonne's computers are interchangeable among other members of the System/360 family.

Argonne National Laboratory is one of the nation's leading centers for research and development in the peaceful applications of nuclear energy. The Laboratory is operated by The University of Chicago for the U.S. Atomic Energy Commission.

Naval Research Lab 6050 Computer System

ASI Computer Division
Electro-Mechanical Research, Inc.
Minneapolis, Minnesota

The U.S. Naval Research Laboratory, Washington, D.C., has purchased an ADVANCE Series 6050 computer system for acquiring and processing data. The system, to be supplied by the ASI Computer Division, Electro-Mechanical Research, Inc., Minneapolis, will be used on-line during the progress of low-energy nuclear-physics experiments conducted with the Naval Research Laboratory's 75-Mev sector-focusing cyclotron.

Data gathered will be stored on magnetic tape and results will be displayed on a cathode-ray tube display unit (CRT). The display of data on the CRT will allow the experimenter to make judgments concerning the experiment in real-time.

The 6050 System, in addition to the central processor, magnetic tape unit, and CRT, includes 8,192 words of memory, input/output character channel, typewriter, paper-tape reader and punch, card reader, and plotter.

The 6050 is one of four systems in the ADVANCE Series computer family. It is specifically designed for scientific computation, on-line systems, and real time applications. Standard hardware features include integrated monolithic circuitry, high-speed memory cycle time, floating point, 48-bit double-precision arithmetic, and three index registers.

IBM 360/67

Carnegie Institute of Technology
Pittsburgh, Pennsylvania 15213

The IBM 360/67 is scheduled to arrive Carnegie Institute in late December. The first three weeks after arrival will be spent in checking out the hardware. IBM Custom Engineers will set up the machine, test the circuitry, components, and run hardware acceptance routines. IBM has delayed delivery of the IBM TSS/360 until August 15, 1967; however, Carnegie will begin using the system in January. System Programmers working on TSS modules will receive 9 hours of machine time a day, and hardware and system maintainers will receive an additional 5 hours a day. Users may use the remaining time. They will be able to operate under two distinct systems: the standard 360 disc operating system, DOS; and a TSS simulation package. During the spring of 1967, Carnegie hopes to have a preliminary version of TSS 360 working, including ALGOL and IPLV. During these first few months Carnegie users are welcome to make use of the system, but will be reminded that numerous difficulties arise when using an experimental system.

Carnegie Tech's IBM 360/67 computer, when in full operation (August '67), will be run under the IBM time sharing system, TSS/360. The basic purpose of TSS/360 is to provide many simultaneous users with conversational access to the computing system; however, it can also perform background, nonconversational processing. By combination of machine and program features, each user appears to have sole possession of the system; and he uses the system as if it had a directly accessible main capacity equal to the addressing capability of the system,

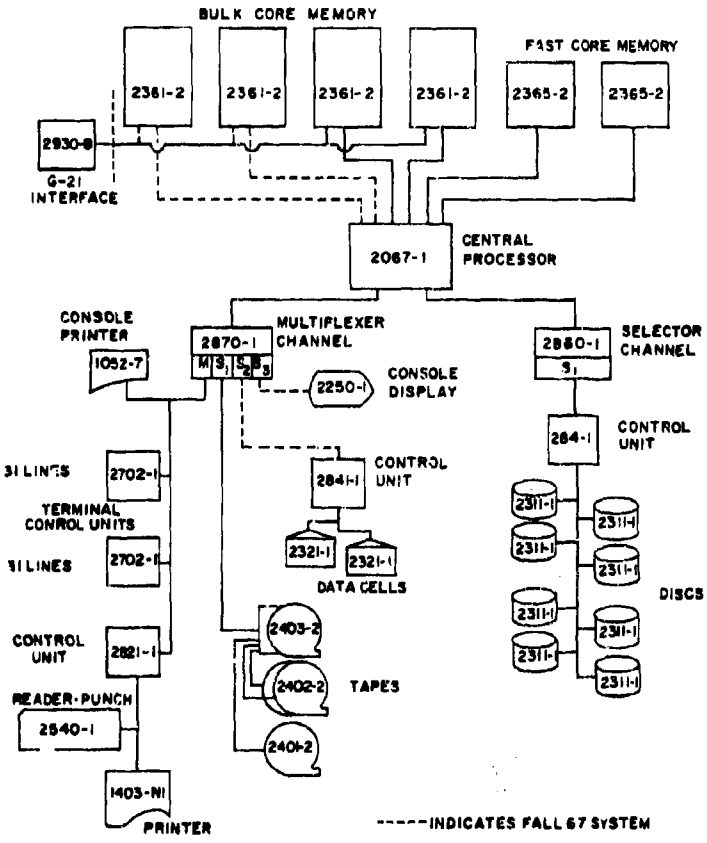

Fig. 1. Carnegie Institute of Technology System 360 Model 67, December 1966

rather than its actual main storage capacity. This is made possible by the use of dynamic relocation. When the computer goes to access a piece of data or an instruction, the computer hardware picks up the address specified by the user and translates it into an actual address in memory. The translation makes use of tables set up by the operating system and a set of associative registers.

Addresses specified by the user are referred to as being in virtual memory while the actual memory locations are referred to as real memory. In Operating System TSS/360 all programs and systems refer to virtual memory addresses except for the resident supervisor which works with real memory addresses.

The IBM operating system operates on three basic levels. The resident supervisor operates on Level 1. Level 1 means that the supervisor is resident in core, that it operates with real addresses (as opposed to virtual memory addresses), and that it operates in the privilege mode (i.e., it is allowed to use special instructions). The supervisor controls the execution of tasks in the system and controls the hardware environment in which they operate. The supervisor's basic function is to respond to interruptions (sort them as to type and function) and initiate the appropriate routines to respond to each. Supervisor routines also control I/O activity and the allocation of machine resources, such as CPU time, main storage space, channels, control units and devices, and provide usage accounting statistics and recovery functions when necessary.

Level 2 programs operate in virtual memory. They are time sliced, paged in and out of high speed core as necessary, and work in the privileged mode. Level 2 programs include the task monitor, data management routines, and the command language interpreter routines. The command language interpreter is the interface between user and the system. It enables the user to enter, mainpulate, and control the running of programs; and it enables operators to control the operation of the system. The data management facilities control input/output devices and provide device-independent operation for system programs and problem programs.

Level 3 programs operate in virtual memory. They are time sliced, paged in and out as required, and work in the non-privileged mode. Level 3 programs consist of language processors, service programs, and user written problem programs. Examples of language processors are ALGOL, FORTRAN, and an assembler. Most programming done here at Carnegie will be done in the Level 3 mode of operation.

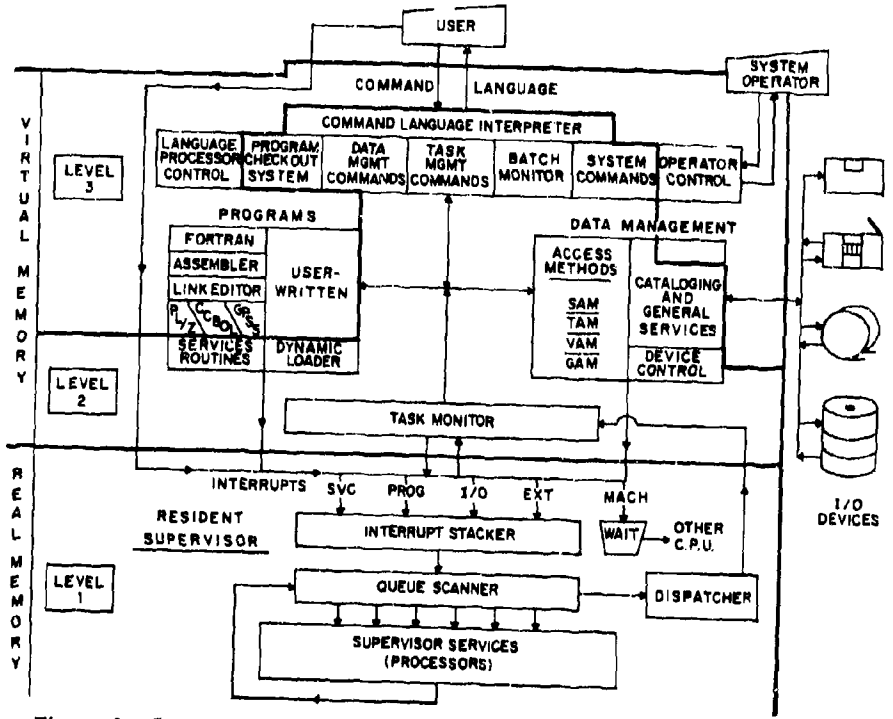

Figure 2. Carnegie System 360 Model 67, Time Sharing System Overview

Time Sharing Overseas Link

Ford Technical Computing Center
Ford Motor Corporation
Dearborn, Michigan 48121

The second direct overseas link in Ford Motor Company's expanding computer network—from Ford of Germany in Cologne to Ford's Technical Computing Center in Dearborn—became fully operational September 1.

"We have been operating the time-sharing link off and on for some time to work out equipment and communications problems," said William A. McConnell, director of system research for Ford's Engineering Staff. "In September, however, our German engineers were able to work problems routinely and use engineering design programs in our library via our time-sharing system."

Ford's computer time-sharing system refers to a network of special teletypes linked by telephone lines to the Technical Computing Center. By teletype, Ford engineers in many locations can directly access and converse with the Dearborn computers. This direct user link greatly increases problem-solving accuracy, and decreases problem-solving time, compared to conventional methods of feeding problems to computers via data on punch cards or magnetic tapes.

"The advantage of bringing the working engineer with a problem, large or small, into direct communication with our computers is hard to overestimate," said Mr. McConnell. "As computer specialists, we are always interested in advanced computer applications. But we feel one of our major contributions to the company at this time is to make the computer as familiar a tool as the slide rule to Ford engineers everywhere."

Ford's time-sharing network first reached overseas to Ford of Britain at Basildon, England, in mid-June. British engineers are in direct user contact with the Technical Computing Center 6 hours daily via telephone.

The telephone links, which connect the two oversoas time-sharing computer terminals to Dearborn, each involve five telephone and cable companies, plus the Teletype Corporation.

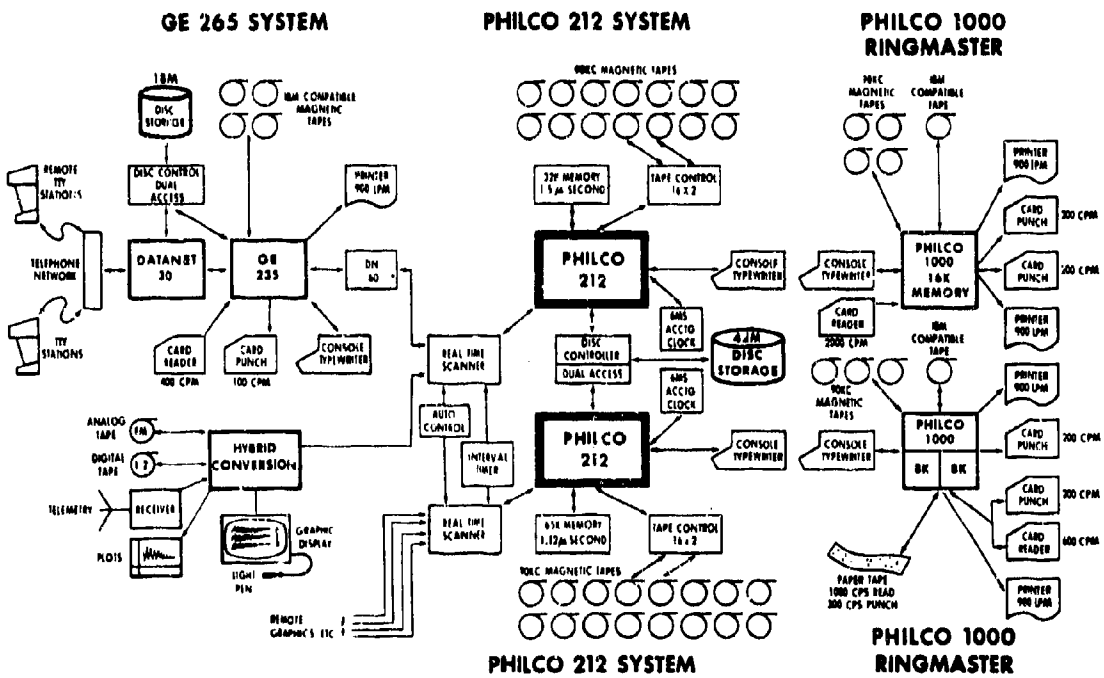

Figure 1. Ford Technical Computing Center

"It took some doing to make the proper arrangements between the various United States and foreign telephone companies in Basildon and Cologne," said Charles W. Missler, manager of Ford computer applications, "because of differences in equipment and procedures. But the quality of communications generally has been quite good."

A Ford team from Dearborn, headed by Benjamin J. Cheydleur, principal computer scientist, coordinated the initial telephone links, installed the terminals, and briefed engineering personnel on computer usage in Britain and Germany.

"We installed the same (United States-made) teletype terminals in Britain and Germany that we use in our domestic time-sharing network," said Mr. Cheydleur, "because the foreign machines use a different signal frequency; however, we had to convert our equipment from 60-cycle ac operation to 50-cycle dc used in both Britain and Germany. Special modulating devices are employed to accommodate line signal differences between British and German telephone transmission versus United States transmission."

Since its activation early this year, Ford's time-sharing network has expanded to 57 remote computer terminals located in key engineering points in Dearborn, across the United States, and now overseas. Time-sharing is accomplished by a satellite computer system, which can be switched into a giant Philco 212 computer system when required. A second Philco 212 system now being installed will make Ford's Technical Computing Center one of the most powerful, if not the most powerful, non-government computing facilities in the world. Similarly, the Ford time-sharing operation is one of the largest in private industry.

Extension of Ford's time-sharing network to overseas subsidiaries has triggered a new computer application: breaking the language barrier among Ford's foreign subsidiaries. On the thesis that Ford engineers of various nationalities will learn to talk to the computer faster in their own language, a special "tutor" program for beginners is, thus far, stored in the computer in German, French, and Spanish, as well as English.

Computers and Centers, Overseas

S-Two Computer

G.E.C. Computers & Automation Ltd.
Wembley, Middlesex, England

G.E.C. Computers and Automation announced in November 1966, the S-TWO, a powerful, low-cost computer for scientific and process control applications and the second machine in the new G.E.C. S-Range to be announced this year.

Featuring multiprogramming and multiprocessing capabilities, S-TWO includes many of the advanced features of S-SEVEN, such as the ability to perform several jobs at virtually the same time. S-TWO features input/output rates of over 5 million bits per second, internal memory speeds of 900 nanoseconds, re-entrant software for optimized foreground and background data processing, a priority interrupt system identical to S-SEVEN, byte organisation of memory, and extensive use of monolithic integrated circuits.

S-TWO may be used as a local or remote satellite processor for S-SEVEN systems; it may operate out of an S-SEVEN memory, or may be used as a stand-alone, general purpose, real-time computer. The S-TWO input/output interface is identical to S-SEVEN, enabling all S-Range peripherals to be operated on either machine. This peripheral equipment includes analogue and digital input/output and operator communication consoles for industrial process control as well as a wide range of devices for general data processing.

Because of the use of integrated circuits, a unique organisation and modular design, S-TWO is constructed with 70 percent fewer components and has fewer interconnections than competitive machines. As a result, the reliability of S-TWO represents a significant advance. A basic S-TWO configuration including paper tape reader and punch, and control typewriter, will cost about 10,000.

Modular programming systems for S-TWO include Basic Control Monitor, FORTRAN IV compiler, real-time compiler, real-time monitor, basic and extended assemblers, and a library of mathematical and utility programs. Software will be available when the first S-TWO computers are delivered in mid-1967.

The modular memory of S-TWO is expansible from 8,192 to 131,072 bytes (4,096 to 65,536 words), (16-bits plus parity) in blocks of 8,192 bytes (4,096 words). S-TWO is the only small computer in which a 65,536-word memory may be directly addressed.

For process control and other real-time applications, S-TWO includes an easily managed protection system which prevents the inadvertent destruction of data or programs, independently programmed input/output operations, multiple real-time clocks which permit several independent programs to have separate time bases and relative priorities, and a priority interrupt system which provides for up to 132 external events to be acted upon by the computer in relation to their importance.

Because of its unique logical organisation, S-TWO is the only small computer which can completely change its environment from one program to another in 4 microseconds. This feature enables general purpose 'background' computing to be carried out without interfering with critical on-line 'foreground' work.

Designed for multiprocessing, several S-TWO computers can directly share a common memory rather than transferring information through input/output channels. In this manner, large multiprocessors can be designed such as for a communications system in which an S-TWO could be used as a preliminary input/output processor while an S-SEVEN is used as a central processor. If a system requires greater capability, several S-TWO computers could be coupled to a common memory and is therefore suitable for a wide variety of on-line control applications.

All instructions for S-TWO are single word only, thereby accommodating larger pro-

grams in a memory of a given size. The S-Range computer also includes an index register, accumulator, an extended accumulator, base address register, general purpose temporary storage register, and a link address storage register.

Two input/output systems are featured in S-TWO. In the byte-oriented system, four input/output channels with a combined throughput rate in excess of 600,000 bytes per second are standard, and up to 20 channels can be provided. An optional external direct input/output system provides for sending and receiving 16-bit data or may be used to generate control signals and sample status conditions without the need of an input/output channel.

S-Range computers will be manufactured by G.E.C. in Coventry under licence to Scientific Data Systems Inc., U.S.A., who named the systems Sigma 2 and Sigma 7.

S-Seven Computer Speed Increase

G.E.C. Computers & Automation Ltd.
Wembley, Essex, England

The memory cycle time of G.E.C. Computers & Automation's S-SEVEN scientific and industrial computer system (see DCN October 1966) reduced from 1.2 microseconds to 850 nanoseconds. S-SEVEN, the first machine in G.E.C.'s new S-Range announced March 1966, is now the only medium-priced computer in its class offering nanosecond main memory speeds. When announced, S-SEVEN represented the first series based on entirely new design techniques since the IBM 360.

At about £200,000 for a typical configuration, the S-SEVEN incorporates features normally found only in computers costing £1 million or more. The system uses nonolithic integrated circuits extensively and has exceptional versatility in real time, time sharing, multiprocessing, and multiprogramming applications, individually or in combination. To qualify for this role, S-SEVEN has the capability of changing its operating environment in 6 microseconds, unequalled by any competitive computer.

Software systems are integrated with the hardware design to take full advantage of S-SEVEN's computing potential. For example, a hierarchy of operating systems permits real time on-line control, conversational time-sharing, batch processing and high speed input/output to occur all at the same time with complete data protection. Compilers available include Fortran IV in excess of ASA specifications, and PL/1, both of which can be easily switched between calculator and conversational modes. Cobol 65 will be available for general data processing applications.

The computer, known as Sigma 7 in the U.S.A., is a product of Scientific Data Systems, and is being manufactured by G.E.C. in the U.K. under licence to SDS. Deliveries start early next year.

New Low Cost Microelectronic Computer

The Marconi Company Limited
Chelmsford, Essex, England

The development of a new microelectronic computer, sufficiently adaptable and low in cost for use in many different types of civil and military automation schemes, was announced by The Marconi Company in September 1966. The new machine, called Myriad II, is a simpler version of the ultra-high speed Myriad I, which was the first commercially available integrated circuit computer, and one of the world's most powerful microminature machines. Myriad II is an extension to the Marconi range; a basic instrument using modular construction techniques which can be built up by adding extra units into a computer with any or all of the Myriad I facilities.

Already Myriad I is being supplied for a wide variety of applications, from controlling Glasgow's traffic to predicting Sweden's changeable weather. Many recently planned military radar and air traffic control systems employ one or more Myriad Is, the computer which caused a storm of interest when it was first introduced at the I.E.A. Exhibition 2 years ago.

Myriad II has been under development since March 1966, and incorporates the same type of Marconi microcircuit elements as used in Myriad I. Similar engineering techniques are employed to construct modules which make the new computer easy to service and enable additional facilities to be added without expensive modifications to the basic machine. Myriad II is also designed to be compatible with Myriad I in order that any programme written for one machine can be fed into the other.

Over 20 million orders per minute can be handled by the new computer, an indication of its high speed which is so important when it is used as a 'real time' machine. Additional equipment, such as tape readers, tape punches, magnetic drums and disc stores, can be attached and these too can have almost instant access to the computer, provided that the information is of importance. This is decided by the priority interrupt system which enables data to be transferred rapidly by interrupting the computer's main programme. Autonomous access facilities enable even more rapid data transfers to be executed independently of the main programme.

The new computer is contained in a well-designed desk and two elegant cabinets. The control unit is mounted on top of the desk alongside any additional pieces of equipment such as tape readers, punches, and teletypewriters.

Myriad II is a parallel computer using a 24-bit word and an order code which is in a simple, single address form, the orders being obeyed sequentially. This simplifies operation and gives a choice between several different methods of arranging the main programme.

Two sizes of store unit are available with either 4,096 or 16,384, 24-bit words, providing storage capacity up to a maximum of 32,768. The stores are coincident current, ferrite core types with a cycle time of 1.5 microseconds and an access time of 0.5 microsecond. If required, magnetic disc or drum stores with average access times of 85 and 10 milliseconds respectively can be added and a maximum capacity of 2 million words is then available.

Myriad II is designed to form the heart of complex data-handling systems in industrial process control and all types of traffic control. Systems can be provided for small control centres which can be built up, as the degree of automation is increased, into a highly sophisticated system as versatile as the Myriad I itself. Myriad I will still be more suitable for those applications where the ultimate in high speed is an important requirement and where rigorous environmental conditions have to be met.

Marconi's new microelectronic computer, Myriad II, was demonstrated for the first time at the October 1966 Electronica Exhibition in Munich. Designed for a variety of on-line applications, it is the second in a range of computers being produced by the British Company who are also displaying a wide selection of products ranging from tiny temperature controlled oscillators to minute microelectronic devices.

A new microelectronic circuit called the 'N' element, mounted in a transistor can no bigger than a garden pea, was viewed for the first time. Though basically an amplifier, the device can be made into a number of different circuits by simply selecting different external connections. It is designed to be compatible with the Micronor II computer logic circuits manufactured by Marconi. This and the Marconi Myriad logic circuit were also featured at the Electronica Exhibition.

Part of a display of specialized components included a range of solid-state high-speed switches recently introduced as a replacement for standard electro-mechanical relays. These remarkable devices have proved so reliable that a prototype batch were operated continuously for months without a single failure.

Marconi microelectronic and specialized components were shown by Marconi Messtechnik, their West German agents, while Myriad II was demonstrated by Controls and Instruments G.m.b.h. who will be offering the computer in systems in Germany.

The new computer, Myriad II, is a compact, low cost machine with a 'myriad' of applications in the field of automation. It is an extension to the Marconi range which, although slower than Myriad I, is a basic machine which can be built up by adding extra units into a computer with most of the Myriad I facilities. This allows it to 'grow' as the complexity of any automated process increases.

Although Myriad II is slower than the highly sophisticated Myriad I, it is nevertheless a high speed, 'on line' computer with considerable versatility which can handle over 20 million orders per minute. Modular construction techniques have been employed throughout, simplifying servicing and the addition of extra facilities.

At the Electronica Exhibition the computer was shown doing simulated processing operations using various types of input and output machines. Amongst these was a new integrated, medium speed papertape console which combines papertape reader, punch and spooler in a single unit.

Miscellaneous

Automated Water Control

California Department of Water Resources
Sacramento, California

California State Water Resources Director, William E. Warne, announced the award of a $325,000 contract for installation of a computer system that ultimately will control operation of the California Aqueduct of the State Water Project. The contract with the Sperry Rand Corporation's UNIVAC Division calls for installation of a UNIVAC 418 System in the project control room in Sacramento by February 1, 1967.

"This is an entirely new concept in the control and movement of water in open conduit," Warne said.

"Initially the computer system will control only the South Bay Aqueduct, but ultimately it will operate all the works along the 444-mile California Aqueduct."

"The South Bay Aqueduct, beginning next year, will be used as a model to develop computer control of the entire State Water Project. Never before has automatic, remote control been used for an aqueduct, even the size of the South Bay Aqueduct."

Control instruments will be installed in the Delta Pumping Plant and at Sacramento to control 22 facilities of the South Bay Aqueduct. The Delta control center will be linked with the control center in Sacramento by telephone microwave facilities.

When the project is fully developed in 1971, there will be additional control centers at the Oroville Dam, San Luis Dam, the Tehachapi Pumping Plant, and at a location not yet selected in Southern California.

"The master control center in Sacramento will monitor and schedule the entire system," Warne said, "permitting operation of the Aqueduct on an 'ever-full' basis."

Warne pointed out that the present control system requires water users to give notice days in advance of changes in the rate of delivery.

Under the automated control system of the State Water Project, changes in water services of the Aqueduct will be sensed by the computer. The water pumps will be turned on and control gates raised to replenish the water diverted from the canal.

"Rigid, pre-planned water delivery schedules as we know them will become a memory," Warne said.

Computer Typesetting Usage

Composition Information Services
Los Angeles, California 90028

During the two years that have elapsed since the first CIS Survey was conducted, the number of computer users in the typesetting application has quickly climbed from 70 to nearly 300 industry firms.

According to the latest investigation, computerized typesetting installations are now to be found in 42 states and in 18 countries throughout the world. It is also of interest to note that at least 19 different hardware manufacturers have computers involved in the generation of typographic tape.

Although the special-purpose computer sparked the commercial birth of computerized typesetting, subsequent development has been characterized by a strengthening of both special—and general—purpose computer involvement. Like the litho versus letterpress debates,

the passage of time has served to confirm clearly the fact that there is a definite place for both approaches to typesetting electronics.

The current study indicates that, for the United States and Canada, general-purpose computers account for 53 percent of the systems in use and, approximately 57 percent of those on order. This gradual increase is largely explained by the continued decrease in the cost of small-scale, general-purpose computers.

In addition to listing the names and locations of users according to specific systems, the Survey provides a geographical breakdown of all graphic arts organizations using computers for typesetting. Each entry also includes the particular typesetting or photocomposition equipment associated with the installation. Two supplements to the Survey list users of the various phototypesetting machines and furnish statistics indicating distribution by industry segments.

The new Survey of Computerized Typesetting has been published by Composition Information Services—a 750-member management organization primarily concerned with the application of new technology to graphic arts production problems, particularly in the composing room.

Organizations with an interest in the activities of CIS, and the most recent Survey, may obtain details by writing to Composition Information Services, 1605 North Cahuenga Boulevard, Los Angeles, California 90028.

Automated Violations Records

Circuit Court of Cook County
Chicago, Illinois

In August 1966, the Circuit Court of Cook County declared computerized war on scofflaws. "In the future," said Joseph J. McDonough, clerk of the court, "the new IBM computer system will help us crack down on persons who ignore parking tickets. Under the new system," he said, "all persons listed on court dockets for moving traffic violations will be screened for delinquent parking tickets. Judges will receive computer-prepared lists of persons with overdue tickets. Violators will have to pay parking fines before their moving violation cases will be disposed of. Parking violators with no moving violations, who have failed to pay their fines, will be contacted within 30 days after court date.

"Collection of parking fines is one of the biggest headaches in city government today. People ignore tickets and some get away with it. We believe that when violators know their next ticket for a moving violation will mean mandatory payment of the parking violations, they will be more careful. "Of course, law-abiding citizens who either pay parking fines promptly or appear before the due date to contest the tickets have nothing to worry about. The system is designed only to catch those who ignore the ticket, the due date, and their legal responsibilities."

Cooperating with Illinois Secretary of State, Paul Powell, and Chicago Police Superintendent, O. W. Wilson, Mr. McDonough's staff merged these records:

From the Secretary of State: reels of magnetic tape containing all auto registration in Illinois–name, address, and license plate number.

From the Police Department: punched cards on all moving violations, vehicle sticker information and notification of issuance of tickets.

From Cook County Circuit Court Clerk's office records: data on overdue parking violations and upcoming moving violation cases.

Now, with the computer, a daily comparison of moving violation cases on the docket with overdue tickets will permit fast follow-up. The old system permitted only an annual follow-up on multiple-parking violators. Police had to apprehend the offenders physically—a process involving massive numbers of man-hours and limited only to multiple-offenses.

In addition to its parking ticket watchdog role, the IBM System/360 Model 30 will check tickets to insure license plates were not reported stolen, City of Chicago stickers are valid, and both license plates and stickers were issued to the same person. "This will encourage timely purchase of both state and city licenses," Mr. McDonough pointed out.

Court records-keeping has skyrocketed since Mr. McDonough became clerk in December, 1960. Traffic ticket volume alone has

doubled—from 1.3 million to more than 2.5 million a year involving revenue increase from $5 to $11 million.

"We needed a fast, large-capacity data processing system," he said. "When IBM announced the advanced System/360 in 1964, we began planning and programming for the system now in effect. We are automating not only traffic ticket records but records of all other divisions and departments of the Circuit Court of Cook County."

The System/360 is:

1. Comparing overdue parking tickets with moving violations cases;
2. Validating city and state licenses;
3. Controlling and reporting some 60,000 personal injury cases in the Law division;
4. Auditing all internal accounts in the Court—the world's largest;
5. Processing records for all 132 city and village traffic courts in the county.

Soon the system will handle some 140,000 cases a year in the Chicago district of the Civil Branch of the Circuit Court. In January, the mechanized bookkeeping was extended to the Probate, Chancery-Divorce, County and Law Divisions of the Court.

Computer Assisted Instruction

Florida State University
Tallahassee, Florida

In September 1966, Florida State University officially opened its Computer Assisted Instruction (CAI) Center. This unique new teaching tool—individualized instruction by computer—which has the support of the state, private foundations, business, and industry, is the result of a joint venture by the University and International Business Machines Corporation. Dr. John E. Champion, president of Florida State University, said the use of computers in teaching and research "may possibly someday be acclaimed the most significant technological contribution to education during this century."

At the opening, an IBM representative turned over to Florida State for study a new 1440 computer and related equipment.

W. J. Deskin, manager of Education Industry Marketing for IBM, told the gathering: "The work that Florida State has been doing in Computer Assisted Instruction research since 1964 has placed it in the forefront of universities exploring the potential of this newest teaching tool. The opening of the CAI Center today is still another major step forward in making the fruits of technology an integral part of the educational process."

Dr. Champion, in accepting the new equipment for study, said: "We regard it as a tribute that IBM has become our partner in exploring this new educational device. This unique university involvement has impressive implications for formal and informal education in its broadest spectrum."

The CAI Center is an all-University research facility and teaching tool and is available to all members of the faculty. It is supported by grants from the University, Florida State Department of Education, and the U.S. Office of Education.

Among those present for today's formal opening were State School Supt. Floyd Christian and Dr. J. Broward Culpepper, chancellor of the state university system, representing the Board of Regents.

Dr. Champion said Florida State entered into the joint agreement with IBM "because it is our obligation to investigate unhesitatingly any technique, method, device, or concept which is potentially capable of improving or extending the teaching-learning process."

The University president said progress in the CAI venture, which has been in experimental use here for two years, was due mainly to "the zeal and competence of our faculty, the benevolent intervention of IBM, and the extremely generous professional and financial support of the Florida State Superintendent of Public Instruction." He pointed out that School Supt. Christian not only supplied funds for the work, which he said has great significance for public school education, but also "has encouraged our work and has more vividly clarified the complementary roles of the University and his office."

Educators envision instruction by computer as a teaching, learning and research tool

at all levels of education, from elementary to post graduate, and one which can be used successfully with individuals ranging from illiterates to honor students.

Dr. Champion said "we believe computer assisted instruction will become a conventional part of our instructional equipment and methodology within the next five years. The results of our studies suggest that it can provide a better education for our students through providing supplementary instruction for enrichment and by assuming responsibility for instructing students in portions of the content of many of our courses."

He continued: "In a genuine, and perhaps ironical, sense we presently regard a machine as potentially enabling the individualization and personalization of instruction on a scale which has never been attainable until now."

Dr. Champion pointed out that work with computers has been assisted by the State, private foundations, the federal government, and business and industry.

"To assure high-level and frontier work it is mandatory that the newest and most advanced equipment be freely available to our faculty members," President Champion said. "Otherwise the result of their work will be obsolescent before it is disseminated and their energies will be dissipated. The University must take advantage of all of these resources to gain the required facilities and it must be ever watchful that its faculty does not study yesterday's problems because only yesterday's tools are available to them."

On the subject of University—business cooperation, Deskin said: Excellence in education today is a matter of enlightened self interest to every member of the data processing and a thousand other industries. How well our schools are performing their job thus is, or should be, of vital concern to every businessman."

Computers do not replace teachers—rather they serve as an electronic intermediary. The teacher must first write a program—or set of instructions—which is then stored in the computer's memory. Those instructions then control a dialogue between computer and student, the pace of which is determined by the student's own abilities. If a student encounters difficulty, for example, the computer may review previous material and, much like a human tutor, introduce additional material until a concept is firmly grasped. CAI promises to enable more students to absorb more knowledge at a savings in time, classroom space, and instruction hours.

"Computer assisted instruction is on the way!" That remark by Glenn G. Boerrigter, of the U.S. Office of Education's Bureau of Research summed up the feeling of speakers in education, government, and industry participating today in the formal opening of the Florida State University Computer Assisted Instruction Center.

"CAI is revolutionary," Dr. Boerrigter continued, "it's quite obvious to me that this new technological development will be used in many schools in the 1970's as one mode of instruction."

FSU President John E. Champion expressed similar feelings at the formal opening ceremonies when he said, "History will possibly record CAI as the most significant technological contribution to education during this Century.

"It is our obligation," he continued, "to investigate unhesitatingly any technique, method, device or concept which is potentially capable of improving or extending the teaching-learning process. Our faculty is mindful of this obligation and quickly recognized the potential benefits of computer assisted instructions to all reaches of education and began its first concerted study of this device in the fall of 1964.

"The Center for Computer Assisted Instruction is engaged in the comprehensive investigation of CAI as an instructional system," Dr. Champion added, "and as a powerful instrument for conducting fundamental research about the teaching-learning process and the human learning process. We are now executing numerous instructional developments and research projects.

"As a result of research findings to date," Dr. Champion said, "we believe that computer assisted instruction will become a conventional part of our instructional equipment and methodology within the next five years.

"In a genuine, and perhaps ironical sense, we presently regard a machine as potentially enabling the individualization and personalization of instruction on a scale which has never been attainable until now."

In formally turning over to FSU for study and IBM 1440 computer and related equipment,

William J. Deskin, manager of the IBM Education Industry Marketing, said, "the work that Florida State has been doing in CAI research since 1964 has placed it in the forefront of universities exploring the potential of this newest teaching tool. FSU is in the forefront not only in the Southeast where it is pre-eminent, but throughout the United States."

Speaking of a joint CAI study begun by FSU and IBM in 1964, Mr. Deskin said, "The opportunity to work with FSU has been an exceptional one as demonstrated by the contribution made here in inquiring into the nature of man's learning itself."

The Center is supported by grants from the University, from the Florida State Department of Education, and from the U.S. Office of Education.

Also speaking at the Center dedication was Dr. J. Broward Culpepper, Chancellor of the State University System.

"For many years," he said, "I have been convinced that instructional materials must be refined, upgraded, and organized into appropriate sequences if new teaching methods are to have a full impact on the educational process. We are especially interested in the phase of computer assisted instruction research which will seek to develop course materials experimentally.

"The evaluation of available materials," he continued, "and the production of improved material will, I predict, enable teachers throughout our educational system to raise their standards."

Mr. Floyd T. Christian, State Superintendent of Public Instruction, announced at the ceremonies that he has approved continued financial support of the Center which he predicted will become a "national mecca for those who share with us concerns for tomorrow and the general betterment within the educational establishment."

Speakers at an afternoon symposium following the opening were Mr. William J. Deskin, Manager of Education Industry Marketing for IBM; Dr. Patrick Suppes, Director of the Center for Mathematical Studies in the Social Sciences at Stanford University; Dr. Glenn Boerrigter, U.S. Office of Education; and Dr. Lawrence Stolurow, Director of the Center for Computer Applications at Harvard University. Dr. Suppes said that a long-term goal of education has been "to tailor the curriculum to the individual student's needs consistent with his ability and his current level of achievement and knowledge."

Citing the instance of Aristotle serving as personal tutor to Alexander the Great, Dr. Suppes said, "the concept of individualized instruction is not new. What is new, though, is the use of CAI," he said, "as a method of achieving this goal that is at once both effective and economically feasible in a mass society which has as its goal universal education for all." Dr. Suppes said that "in addition to offering the possibility of truly individualized instruction for each student, CAI also offers a number of benefits to both teachers and to educational researchers and curriculum writers. "What we can hope to do with CAI, with respect to the teachers," he said, "is to take a great part of routine load off the teacher's back so that he can concentrate on more individualized work with one student at a time."

Dr. Suppes also discussed the idea that CAI would force the teacher to focus his attention solely on slow learners. "Bright children have to be helped out of learning difficulties just as slower children do," he said, "that is, each student is working according to his own pace and, at given points in the curriculum, needs help and guidance that only the individual teacher can give. What the elementary school teacher will not have to do," he continued, "is to go through many routine tasks that are inevitably a detrement with respect to giving the maximum attention that she could give to her children."

Curriculum writers and educational researchers will have available to them, through CAI "the opportunity to gather data about complex subject matter at a depth that has simply not been possible before," Dr. Suppes said, "we are truly on the edge of a scientific revolution in education as CAI makes possible the presentation of curriculum material in an environment where the computer's tremendous information gathering resources can be used effectively to gather data that will permit objective and scientifically deep investigation of learning and the learning difficulties that students have. "As yet our knowledge of how students learn—how a particular segment of subject matter is processed by students—is very poor indeed."

Dr. Suppes also described three types of CAI systems: individual instruction and drill; tutorial; and dialogue.

"Instruction and drill is the simplest and most immediate application of CAI," he said,

"in teaching students specific skills. In tutorial CAI, extensive use is made of recorded speeches in response to a student's work at a computer terminal. An ultimate goal in tutorial CAI," he said, "is in development of speech recognition devices which will enable students to talk to the computer directly, rather than to type in answers to questions.

"The development of CAI to a point where true dialogues can be carried on verbally between students and computers—much like Aristotle and Alexander—is farthest from reality," Dr. Suppes said, "but it is something which we should be thinking about now."

Dr. Stolurow, in reviewing his work in CAI, emphasized the need for methods of analyzing the teaching process. "The goal in this," he said, "should be to adapt the teaching environment to the individual student rather than vice versa."

"To achieve this," he said, "it is necessary to determine the student's ability, prescribe a course of action, and make corrective models of the course of action based upon the student."

The results of his studies to date, Dr. Stolurow said, convinced him that "in CAI we have a long road ahead to achieve true individualization of instruction via the computer."

Dr. Boerrigter, in his remarks, announced that the U.S. Office of Education is doing preliminary work in launching a project to determine what modifications will have to be made in elementary and secondary schools and institutions of higher learning to successfully phase CAI into the educational process.

"While we have not yet negotiated a contract," he said, "the Bureau of Research will probably arrive at an understanding with non-government personnel such as teachers, social psychologists, engineers, architects, and administrators to confer about the implications of computer assisted instruction.

"This will enable the Bureau of Research to plan and establish priority areas for the funding of research and development."

Florida State University's CAI Center is administered by the Institute of Human Learning under Dr. Russel P. Kropp. It is an all-University research and teaching facility and it is available to all members of the Florida State faculty. Dr. Duncan Hansen is CAI Director; other staf members include Dr. Howard Stoker and Dr. Walter Dick. Dr. Frank Benham is IBM consultant at the Center.

Currently CAI research at FSU has three major objectives: research and evaluation, through comparison of CAI studies with conventional instructional groups; the implementation of CAI as a University instructional technique with programs ranging from nursery school to the post-doctoral level; demonstration of instructional capabilities to show the substantive results of studies into CAI potential.

The final goal of this research is to study simultaneously the teaching strategies, the nature of instructional material, the attitudes of students toward the learning process, and the interaction of all three of these.

Computerized Medical Course

University of Oklahoma Medical Center
Oklahoma City, Oklahoma

In September 1966 the nation's first computerized medical school course was unveiled by the University of Oklahoma Medical Center.

Dr. Edward Brandt, director of the university's Medical Center Computer Facility, said, "The first course to be taught using computer help is Medical Backgrounds, a required course for graduate student enrollees in preventive medicine and public health."

He said the course, taught by Dr. Thomas Lynn, continues to be a two-hour course. After each two lecture hours, however, students spend one hour studying the appropriate computer assisted instruction (CAI) material previously put into the computer.

CAI has been used at several United States colleges and universities; however, the Oklahoma medical school is the nation's first graduate facility using CAI in a credit course.

CAI employs standard IBM equipment and an IBM symbolic programming language, Coursewriter. This language makes it easier for educators to put course materials into computers.

Dr. Brandt said, "Our 1401 simultaneously instructs four students sitting at typewriter-like

IBM 1050 terminals. Eventually we will have terminals for as many students as our curriculum and enrollment demand. Each station will have access to any of the courses within the computer. "We soon will have a larger-capacity computer and currently are transcribing two more courses for CAI, with three more being planned."

Medical Backgrounds, a survey course in medical terms and procedures, is the first Oklahoma CAI attempt. A refinement of CAI technique permitted Dr. Lynn to put his course into the 1401 indirectly, using dictation equipment and a highly-trained typist.

Mr. William Harless, manager of educational applications at the center, explained:

"A restriction in using computers for instruction in the past has been the many hours needed to instruct the computer. Even with the simplicity of Coursewriter, which has relatively few commands, it could take a teacher up to 250 hours to program just 1 hour of CAI material. Our technique, called Vocal Programming, involves a minimum of teacher training. The professor dictates his materials in general terms into a recorder, instead of entering it directly into the computer. A highly-trained typist who knows Coursewriter then is responsible for transcribing the material into the exact commands for entry into the 1401 by means of the 1050 terminal. Specialists on CAI are available to edit the program for storage in the computer, where it is held until called for by students." He said the technique cut the programming time required in the school's first attempt to four hours of professor time for each CAI hour.

Announcement of the program was made in conjunction with a two-day seminar on "Computers in Medicine." The seminar featured one day each devoted to computers in scientific and research activities, and computers in peripheral medical activities such as hospital management and education.

Mathematical Systems Chart

The Pennsylvania State University
University Park, Pennsylvania 16802

An organizational chart for mathematical systems is being devised by a computer scientist at The Pennsylvania State University.

Much like the periodic chart of chemical elements first developed by Dmitri Mendeleyev in 1869, this chart should organize branches of mathematics into a formal structure, stated Dr. Preston C. Hammer, professor of computer science.

The chart will be a means of formulating a basic framework of mathematics for computer use. Mathematics is not general enough now to meet all the demands of computing theory, Professor Hammer said. One of the fundamental problems troubling computer scientists is that they cannot predict what people will expect from computers in the future. A basic organization of mathematical systems should help make this possible.

Computers perform a multitude of duties today ranging from translating one language into another, to manipulating models of the United States economy, to calculating plans for new satellites destined to circle Earth. Future demands on these machines will be far greater, and meeting these will depend on a basic understanding of the symbols and language of mathematics.

Any kind of language, even our own, is built on interrelated symbols, Dr. Hammer, head of the department of computer science at Penn State, said. Patterns of ink on the pages of a book have no importance unless they represent something to the reader. They must form a symbol that has meaning. Most of our advertising, teaching methods, and daily activities are based on symbols, he continued. Even people become symbols, representing their city, nation, club or the organization that employs them.

The language of mathematics is full of symbols. Letters are often used in place of numbers during calculations. The language itself symbolically describes certain types of information or structures. Computers utilize these descriptions to put the information into a more usable form; but computers must work with fundamentals, and advanced mathematics is difficult to break down into simple symbolic forms. The formal structure of the mathematics chart being devised by Professor Hammer should present very complicated mathematical processes in basic form.

Then computers may be able to use these processes as may other areas of scientific research—chemistry, physics, biology, and even astronomy.

The computer scientist said that basically the chart will show the relationships between objects. It will be quite similar in form to the chemical periodic chart; but within its organization there will be holes—spaces left for missing pieces since many aspects of mathematics are still unknown. Like Mendeleyev, Hammer hopes to predict what the missing elements will be like, but says that it could take many lifetimes before all of them are discovered.

Education Information System

Superintendent of Public Instruction
Springfield, Illinois 62706

The state superintendent of public instruction, Mr. Ray Page, in August, announced plans for a computerized statewide education information system affecting all 1,347 school districts in Illinois.

Superintendent Page said: "Nearly half of the 2,087,689 public school students in the state are served by some form of data processing system, and when our new information system is complete, we will help to serve all school districts and students in the State of Illinois. The IBM System/360 Model 30 will be the nucleus of the planned information system. It will take several months to put the program into full operation.

"Our system will offer consistent, efficient, and economic data processing information for analysis on students, teachers, finances, facilities, and curricula for both state and federal educational agencies. This will insure Illinois' participation in the 13-state Midwestern States Education Information Project coordinating the development and implementation of educational data processing throughout the midwest.

"Committees have been organized for each of the five reporting sectors: pupils, personnel, finance, facilities, and educational programs. Committee membership includes top educators from local school districts, related educational groups, and other professions. Our aim is to provide instant and accurate reporting on a need-to-know basis. Reports vital to local operations will be available from district offices. From there information will be summarized and reports forwarded to state, regional, and federal levels. Each agency will receive only those items of information necessary to administer its own educational programs effectively."

Experiments in Citation Indexing and Bibliographic Coupling

National Bureau of Standards
Washington, D.C. 20234

The Office of Standard Reference Data is conducting experiments to gain familiarity with remote on-line access to computers, and to explore the use of citation indexing and bibliographic coupling for solving retrieval problems.

The Office has obtained limited access to Project MAC's large computer at Massachusetts Institute of Technology. This computer has unexcelled facilities for remote on-line access and contains a large file of bibliographic references from the periodical literature in physics. The only file of its kind, it is completely computerized, and therefore uniquely suited for these experiments. The file lists all papers in recent volumes of leading physics journals, as well as the literature references cited in them. Thus it is possible to search for recent papers citing an older paper, and to search for papers which have citations in common with another paper.

Such sharing of citations ("bibliographic coupling") implies that the papers pertain to related subjects, although this is not necessarily true. Suppose, for example, that a scientist wishes to find the latest value for the atomic weight of some element. He knows that this was measured some years ago, and that it may have been revised since. He enters the index with the latest publication on this subject known to him—perhaps 5 or 10 years old—in the hope that the publication of a subsequent revision would reference the previous result. This kind of problem occurs frequently in operations such as those of the NSRDS data centers.

Other applications of a citation index are preparing bibliographies, maintaining awareness of current programs, and finding reviews of a paper or corrections to it. These examples may suffice to show that a citation index is not only a useful tool in many scientific undertakings, but is also particularly applicable in a system such as NSRDS.

Studies of long-distance access to computers may result in retrieval of data stored in computers all over the country by customers using inexpensive general-purpose terminal facilities. The technology for doing this is already in existence and may be used before long for a variety of purposes. Remote computer terminals may soon be within easy reach of many scientists and engineers, and at that time access to a central computer file of standard reference data is one service which NSRDS should be prepared to offer.

Mechanized Information System

The Moore School of Electrical Engineering
Philadelphia, Pennsylvania 19104

The Moore School of Electrical Engineering, University of Pennsylvania, has been engaged in research in the field of information retrieval for the past five years. All aspects of information retrieval have been examined from the acquisition of technical documents through cataloging, indexing, and the mechanization of storage and retrieval. A mechanized system which was programmed over an 18-month period, was put into operation around the first of the year. The file includes 1500 documents of the ACM Repository, of which the Moore School is custodian, computer theses and dissertations, and a number of research reports submitted by individual authors. The originators of these documents varied extensively, including individuals, companies, universities, government agencies, and professional societies. They average about 50 pages in length, ranging from 1 page to more than 300. They are all related to the software and hardware aspects of the computer field.

The current research study is primarily concerned with formal structural classification of recorded technical information and the process by which human users learn to interpret an information system classification plan through real-time on-line search for documents or document descriptions from the mechanized file.

The mechanized system incorporates a 33-ASR Teletypewriter connected by a Dataphone to a PDP-5 which is in turn connected through a second interface to an IBM-7040 computer equipped with a 1301 random-access disk. The PDP-5 is used for all message buffering, format conversion, and editing functions. The most important of these is the editing, and one of the first tasks accomplished was the design of an editing language. This language allows the searcher to formulate complicated commands on-line in real time at the remote Teletype. He has provisions available to him for deletion and replacement of individual characters, entire lines, or complete messages. Before the information retrieval programs contained in the 7040 computer process the command, the operator may, at his option, request that the command be typed at his remote station. All changes that he has made will appear when the command is typed back. He may approve the command, in which case it will be transmitted from the PDP-5 to the larger computer for processing. Or he may make additional changes, and again elect the option of having the current command reproduced at his console. (The language also provides for a short form of the above procedure for use in the case of simple responses to queries from the PDP-5, such as the response "YES.")

A number of advanced technical principles and implementation criteria have been developed and serve to guide the project. These may be summarized as follows:

1. The user will have direct access to the system via on-line console.

2. In addition to the document catalog and indexing data, the system will store a complete description of itself. Thus, the user will have readily available to him via on-line console, an up-to-date description of how the system is organized and how best to search in response to his own specific and immediate need(s).

3. The user will be permitted to use an unrestricted search vocabulary. It is a feature of the plan that the system will respond to most index terms (word or word phrases) that it has previously encountered, even though it operates with a limited authority list or microthesaurus or lexicon of descriptors.

4. The user will gain access through any one or more of a large number of entry ports.

This is equivalent to providing an adaptive man-machine interface by means of which the indexing structure adjusts and responds to the user's current interest profile.

5. The user will be permitted to search stochastically through the system. This parallels the conventional search through Roget's Thesaurus, by means of which the user is able to attain the most applicable word from an initial approximation by searching through related categories, sections, and/or classes.

These principles are reflected in the following features of the Moore School mechanized system:

- retrieval by on-line search via remote console, including a man-machine dialogue which is directed by the system through sequences of context-dependent machine-generated statements ("directed dialogue");
- provision for help of the kind that a librarian gives an individual looking for information, such as how the cataloging and retrieval system works and what kinds of documents it contains;
- unrestricted search vocabulary with automatic mapping onto the controlled system vocabulary;
- transformation tables for three echelons of index terms... transients, free terms, and descriptors; and
- capture of search data to expedite study of search strategies in such machine-directed on-line retrieval from a mechanized file.

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Monitor Data System

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The Monitor Data System at the University of Pennsylvania provides a facility for the storage and retrieval of comprehensive technical data on electronic systems, equipments, and assemblies.

Presently under contract to the U.S. Navy, Bureau of Ships, immediate and anticipated applications of the Monitor Data System include the following:

1. Management of provisioning records for the Bureau of Ships.

2. Automatic programming of automatic test equipment, particularly in connection with the NEL (San Diego) Assembly Tester.

3. Generation of input data for the NASL generalized system performance effectiveness analyzer.

4. Storage and retrieval of the details of standardized circuit functions for equipment design. In addition to computer-generated information, output from the system may include pertinent documentation from the Monitor Data System aperture card file. The aperture card file contains microfilm copies of all specifications and drawings which are used as source documents for the information stored digitally.

During the third quarter of 1966, the Monitor Data System was updated from a four-tape IBM 1401 configuration to a random access file in connection with an IBM System/360 model 30.